Exploration and analysis of dynamic environmental indicators –

Based on the NEISGEI approach

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Suggested Indicator Selection Criteria

- *Primarily national in scale or scope, but drawing from state and county levels where possible*
- *Relevant to the main objective of assessing progress towards a healthy environment*
- Understandable, that is to say, clear, simple and unambiguous
- Realizable within the capacities of US EPA, given logistic, time, technical and other constraints
- Conceptually well-founded
- Limited in number, *remaining open-ended and adaptable to future developments*
- Representative of a scientific consensus, to the greatest extent possible, on the features of a healthy environment
- *Dependant on data that are readily available or available at a reasonable cost to benefit ratio, adequately documented, of well known quality, and updated at regular intervals.*

(Adapted for EPA's mission from the UN Commission on Sustainable Development "Driving force – State – Response (DSR)" framework for indicator development)

NEISGEI: **N**etworked **E**nvironmental **I**nformation **S**ystem for **G**lobal **E**missions **I**nventories

…is both a conceptual framework and implementation effort for the development of a fully integrated, distributed air emissions inventory – and the foundation for an all-media environmental information network

- ❖ Tie together data at all spatial and temporal scales using emerging distributed database technologies

- ❖ Provide shared, online tools for processing and analysis

- ❖ Provide for the seamless merging, manipulation and analysis of Internet accessible air quality-relevant data through the development of emerging Internet-oriented technologies

- ❖ Make use of existing resources – partner/link with others and their related projects

- ❖ Build a broad-based air quality user community: scientists, regulators, policy analysts and the public

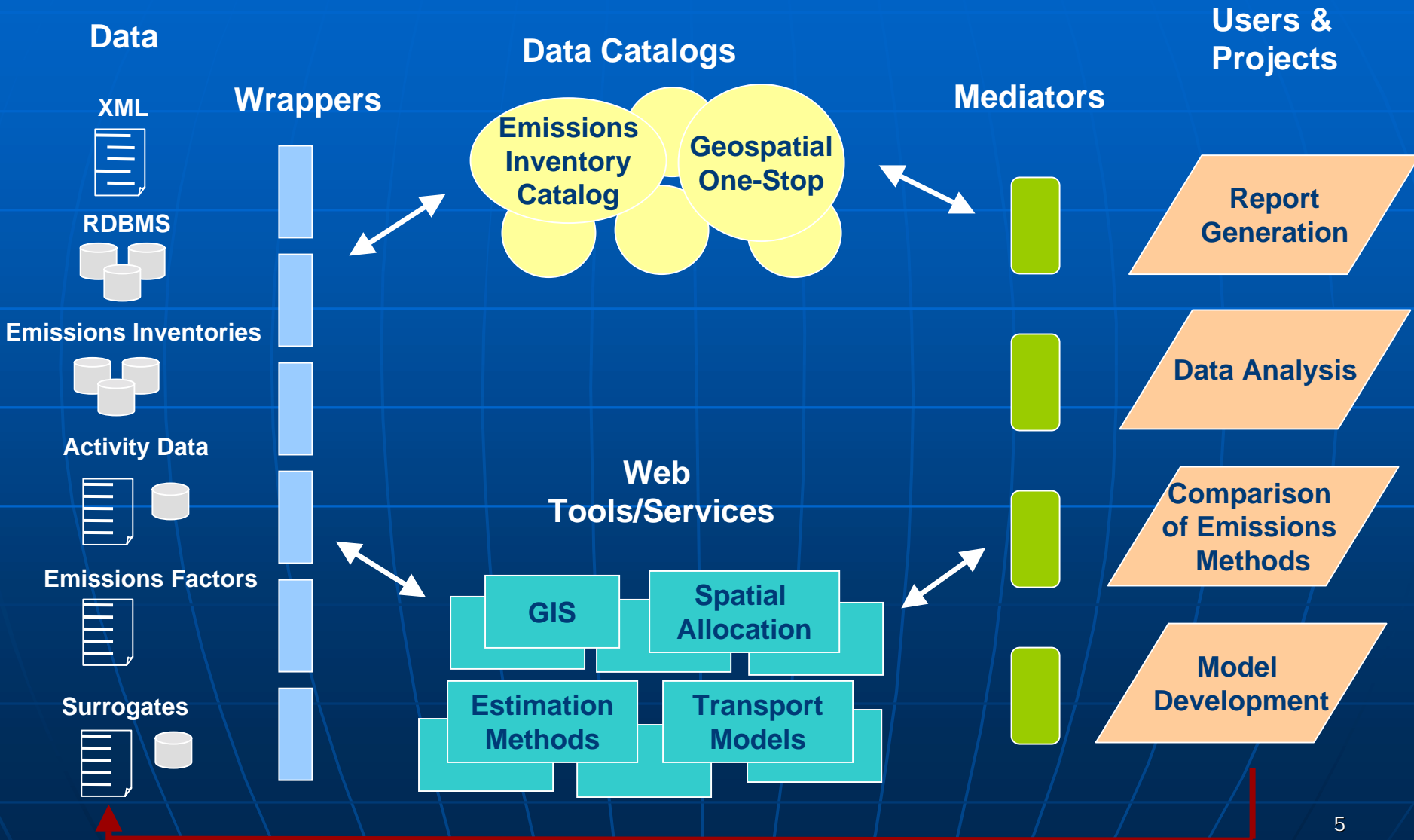- ❖ Create the network and toolkit via specific, task-oriented projects

All of these efforts can <u>also</u> lead to a system capable of providing a window into the well-being of the environment – a <u>dynamic</u> window

Air Quality Indicators
listed in the _US EPA – Report on the Environment_

- Number and percentage of days that the metropolitan statistical areas (MSAs) have Air Quality Index (AQI) values greater than 100

- Number of people living in areas with air quality levels above the NAAQS for particulate matter and ozone

- Ambient concentrations
  - Particulate matter: PM2.5 and PM10
  - Ozone: 8-hour and 1-hour
  - Lead

- Emissions:
  - Particulate matter (PM2.5 and PM10),
  - Sulfur dioxide
  - Nitrogen dioxides
  - Volatile organic compounds and
  - Lead
  - Air toxics

- Visibility

Envisioned Emissions Community Resource of Data & Tools

Data

Data Catalogs

Users & Projects

XML

Wrappers

Mediators

Emissions Inventory Catalog

Geospatial One-Stop

Report Generation

RDBMS

Emissions Inventories

Data Analysis

Activity Data

Web Tools/Services

Comparison of Emissions Methods

Emissions Factors

GIS

Spatial Allocation

Surrogates

Estimation Methods

Transport Models

Model Development

Distributed Data and Management Networks

Advances in information science and technology are driving the trend toward distributed networks and virtual communities for science and management.

- **Cyberinfrastructure**

  NSF's initiative to apply new IT to building new ways of conducting collaborative research

  http://www.cise.nsf.gov/sci/reports/toc.cfm

- **Earth Observation Summit**

  International effort to build comprehensive, coordinated, and sustained Earth observation systems

  http://www.earthobservationsummit.gov

- **Ecoinformatics**

  EPA's vision for national and international cooperation in data and technology development

  http://oaspub.epa.gov/sor/user_conference$.startup

Integrated Ocean Observing System

International network of ocean related monitoring, assessment, and communication

http://www.ocean.us/

Linked Environments for Atmospheric Discovery

Network of high-performance computers and software to gain new insights into weather

http://lead.ou.edu/
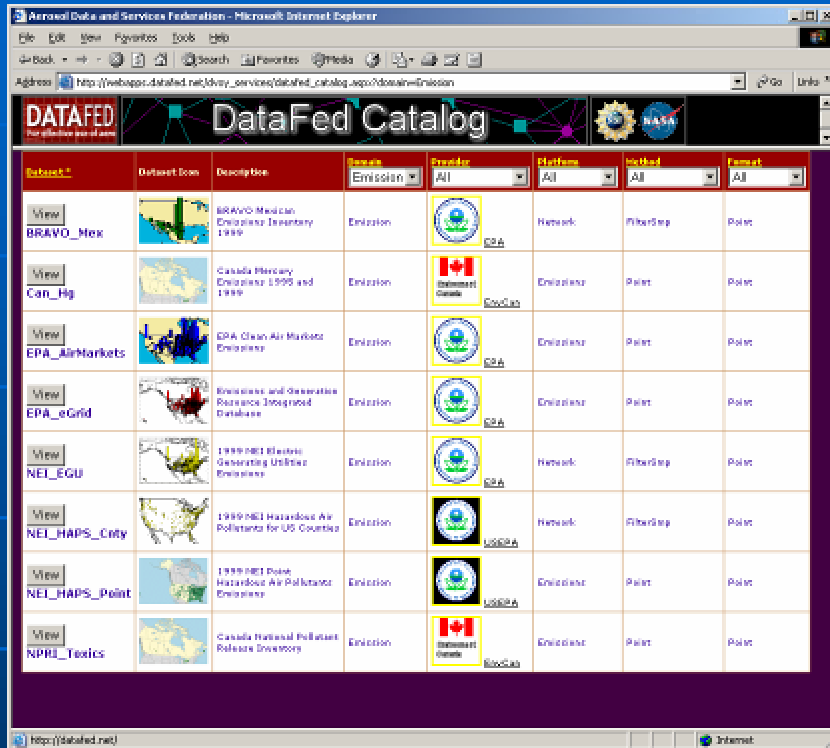
DataFed.net

Network for aerosol and atmospheric science data sharing and distributed analysis

http://www.datafed.net/

Catalogs with Distributed Air Quality Related Data
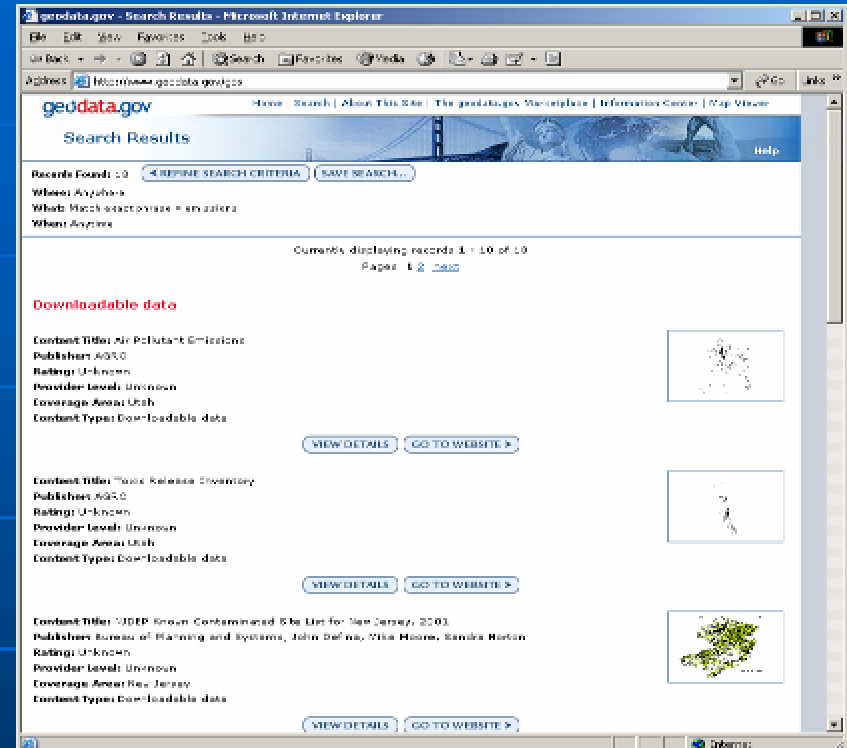
www.datafed.net

www.geodata.gov

DataFed

Geospatial One-Stop

Metadata for each dataset are registered in a catalog allowing users to browse available datasets and determine which datasets to use for their particular application.

# Mapping Multiple Databases into a Single Format

Emissions inventories are based on different underlying data models.

Each inventory uses a uniquely defined set of field names. However, many of these field names are similar to (or their content is similar to) fields in another country's inventory.

Some of the key relationships among the inventories have been captured by developing a "mapping" among fields.

SO2
SO2_Ann
Sulfur Dioxide
SO2Yr

SO2
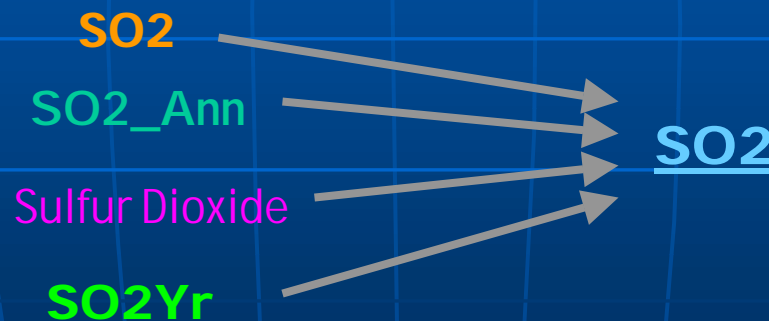
These mappings provide a set of connections that can subsequently be applied to <u>automated query</u> and <u>integration of data</u> from multiple inventories.

CAREN: The California Air Resources Network

Eduard Hovy, Jose-Luis Ambite, Andrew Philpot
USC Information Sciences Institute

Environmental data sharing among international, national, state and local governments, the public and academic and other non-governmental research organizations is a significant challenge.

**Barriers to sharing** include:

- ➤ Technological incompatibilities
- ➤ Data format incompatibilities
- ➤ Financial (staff time) limitations

**The Solution Strategy (first step):**

- ✓ _**Automate the integration of heterogeneous databases**_

(Use semi-automated information integration methods to generate translation protocols between related information sources, e.g. AQMD and CARB.)

US EPA

RPOs

States

Tribes

AQMDs

Municipalities

???
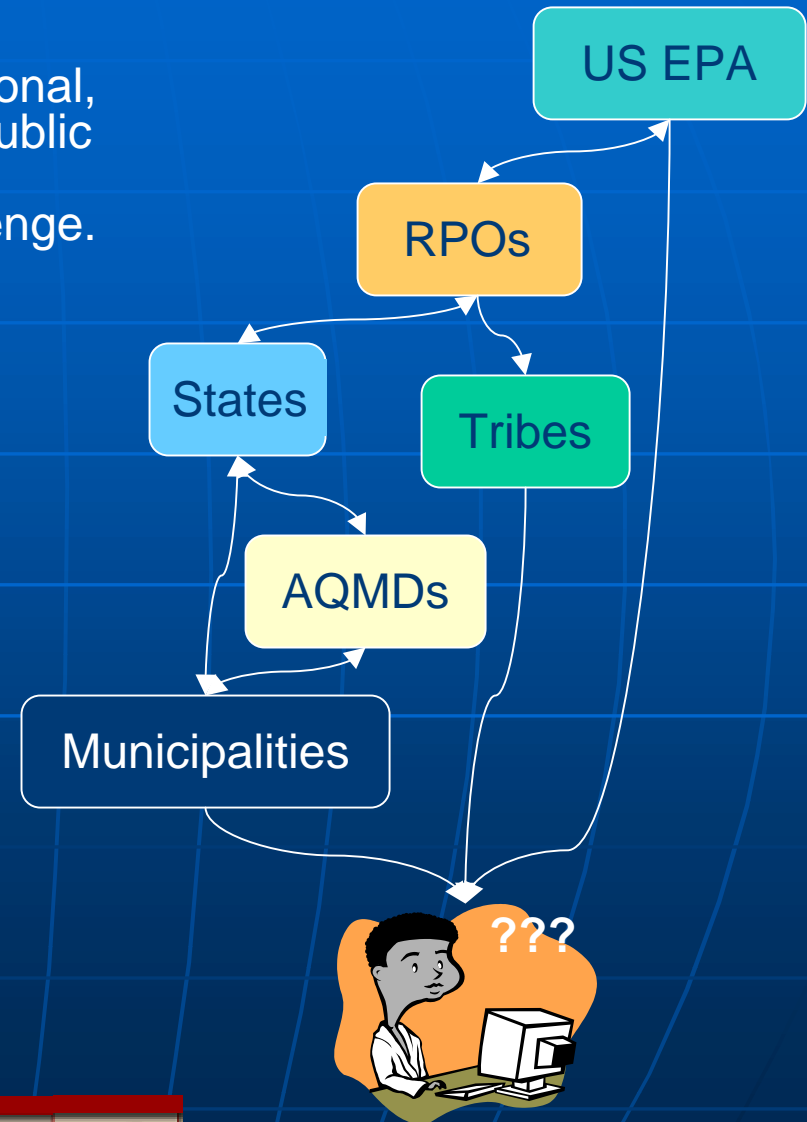
Next Step: Tools Built from Web Services

Example:

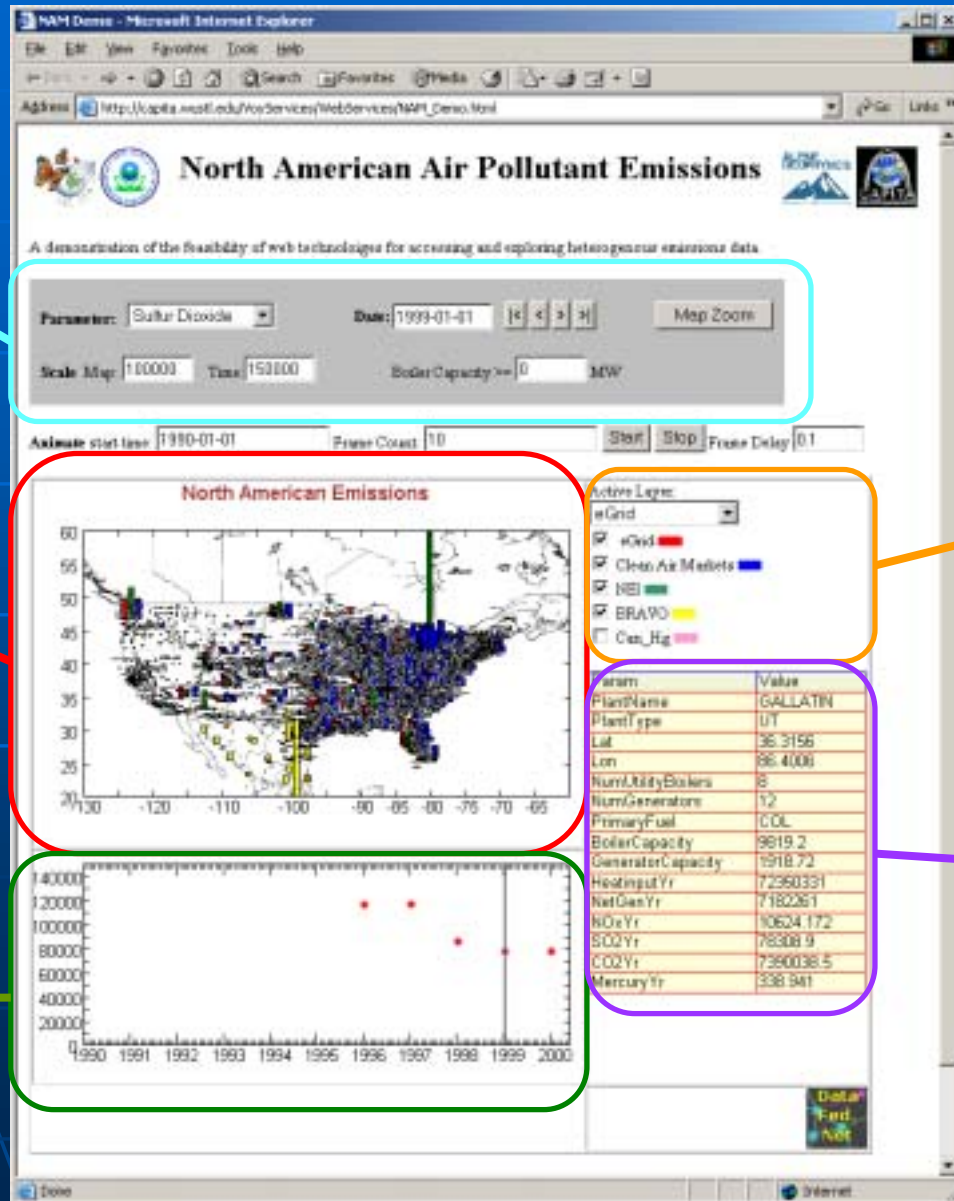*The North American Power Plant Emissions Inventory*

Emissions data from multiple databases are displayed on maps, time series, and tables. Tools are included for browsing and querying the data.

Here, the user can change the pollutant, date, map zoom data on/off, and map/time scales.
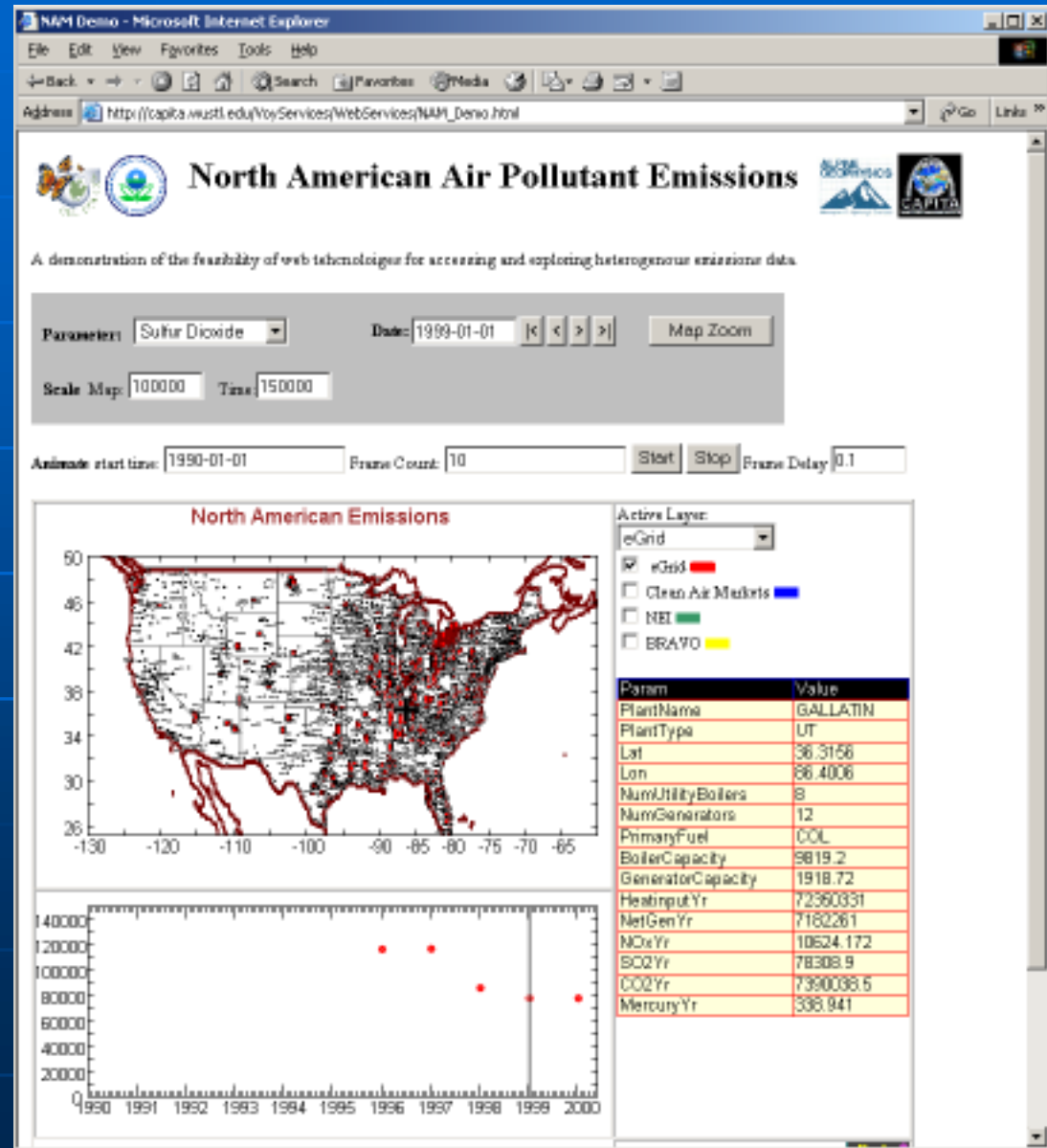
Example Web Application Components

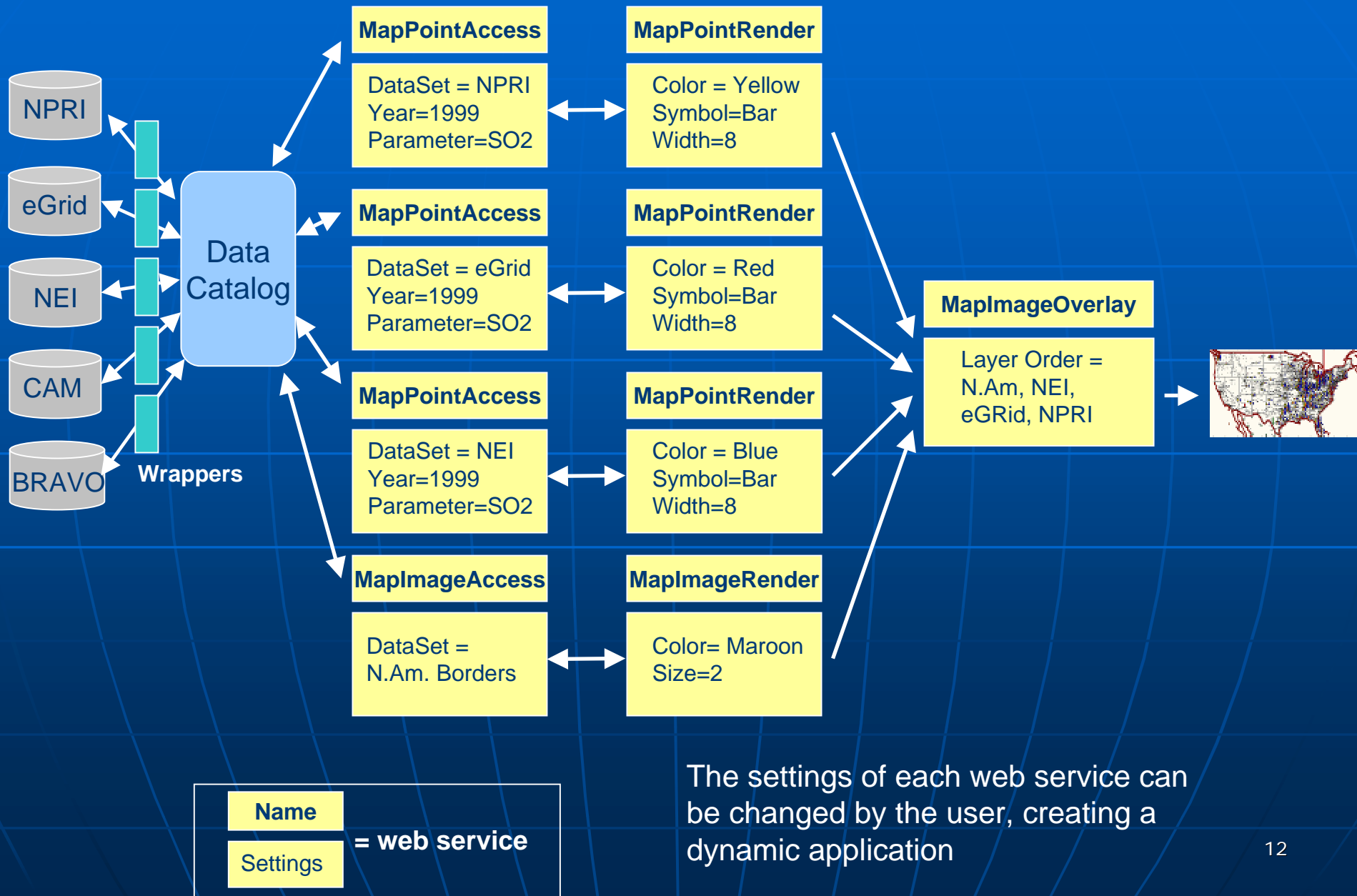**Control Panel**
controls the views

Data Layer Control
controls the layers to display in the map and which layer is active (displayed in the time and table views)

Map View
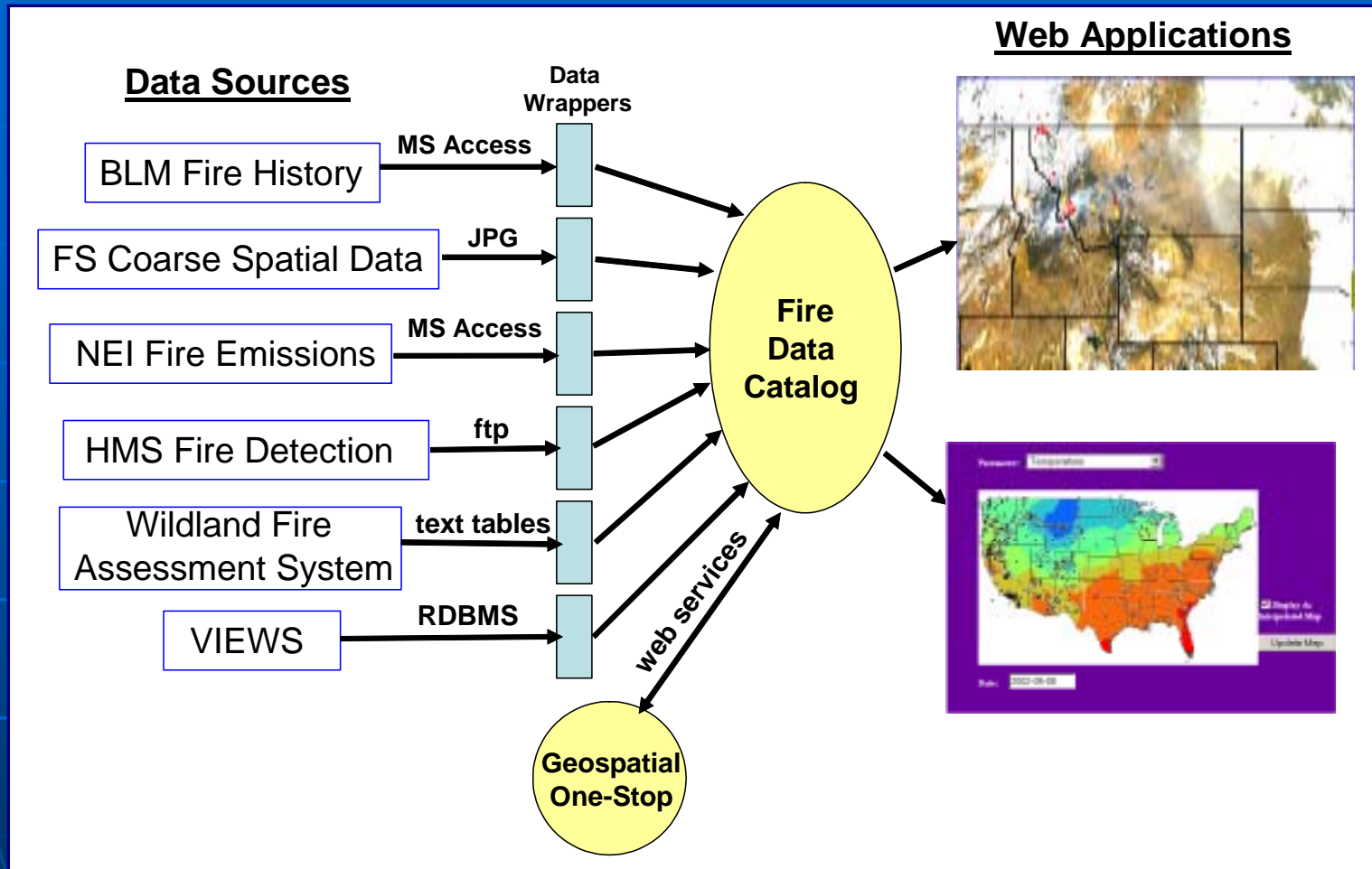displays tons of emissions as proportional bars

Time View
displays a time series of emissions for a selected facility

Table View
displays the data record for a selected facility

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North American Emissions Demonstration Data Flow

NPRI

eGrid

NEI

CAM

BRAVO

Wrappers

Data Catalog

MapPointAccess

DataSet = NPRI
Year=1999
Parameter=SO2

MapPointRender

Color = Yellow
Symbol=Bar
Width=8

MapPointAccess

DataSet = eGrid
Year=1999
Parameter=SO2

MapPointRender

Color = Red
Symbol=Bar
Width=8

MapPointAccess

DataSet = NEI
Year=1999
Parameter=SO2

MapPointRender

Color = Blue
Symbol=Bar
Width=8

MapImageAccess

DataSet =
N.Am. Borders

MapImageRender

Color= Maroon
Size=2

MapImageOverlay

Layer Order =
N.Am, NEI,
eGRid, NPRI

Name

Settings

= web service

The settings of each web service can be changed by the user, creating a dynamic application

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Another Example: *Fire and Air Quality Data Network*

Data Sources

Data Wrappers

Web Applications

- BLM Fire History — **MS Access**
- FS Coarse Spatial Data — **JPG**
- NEI Fire Emissions — **MS Access**
- HMS Fire Detection — **ftp**
- Wildland Fire Assessment System — **text tables**
- VIEWS — **RDBMS**

Fire Data Catalog

web services

Geospatial One-Stop

➢ Data 'wrappers' are used to translate the format of data sets into a uniform format.
➢ The data are either stored on the CAPITA database server or dynamically accessed from its original source
➢ The datasets are registered with metadata in the data catalog
➢ GIS-type interfaces provide users with ways to view, analyze, and export the data

Spatial Interpolation Service

call
service

return
results
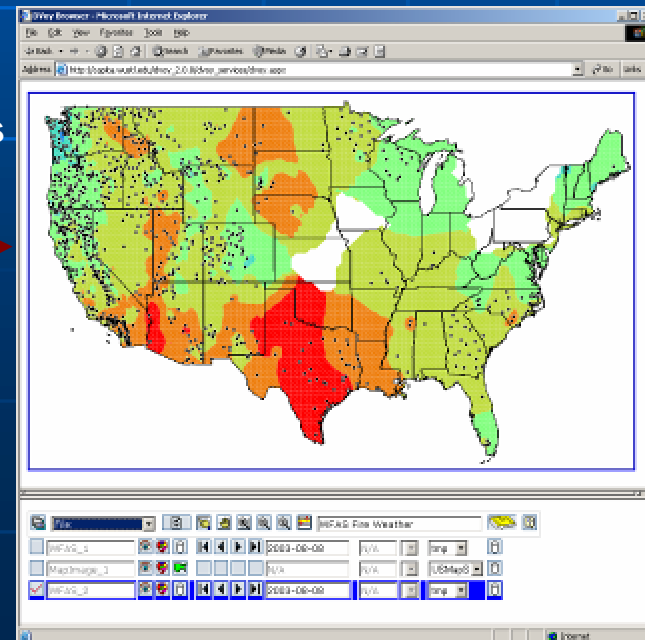
A spatial interpolation web service allows
dynamic creation of continuous surface data
from a point data set.
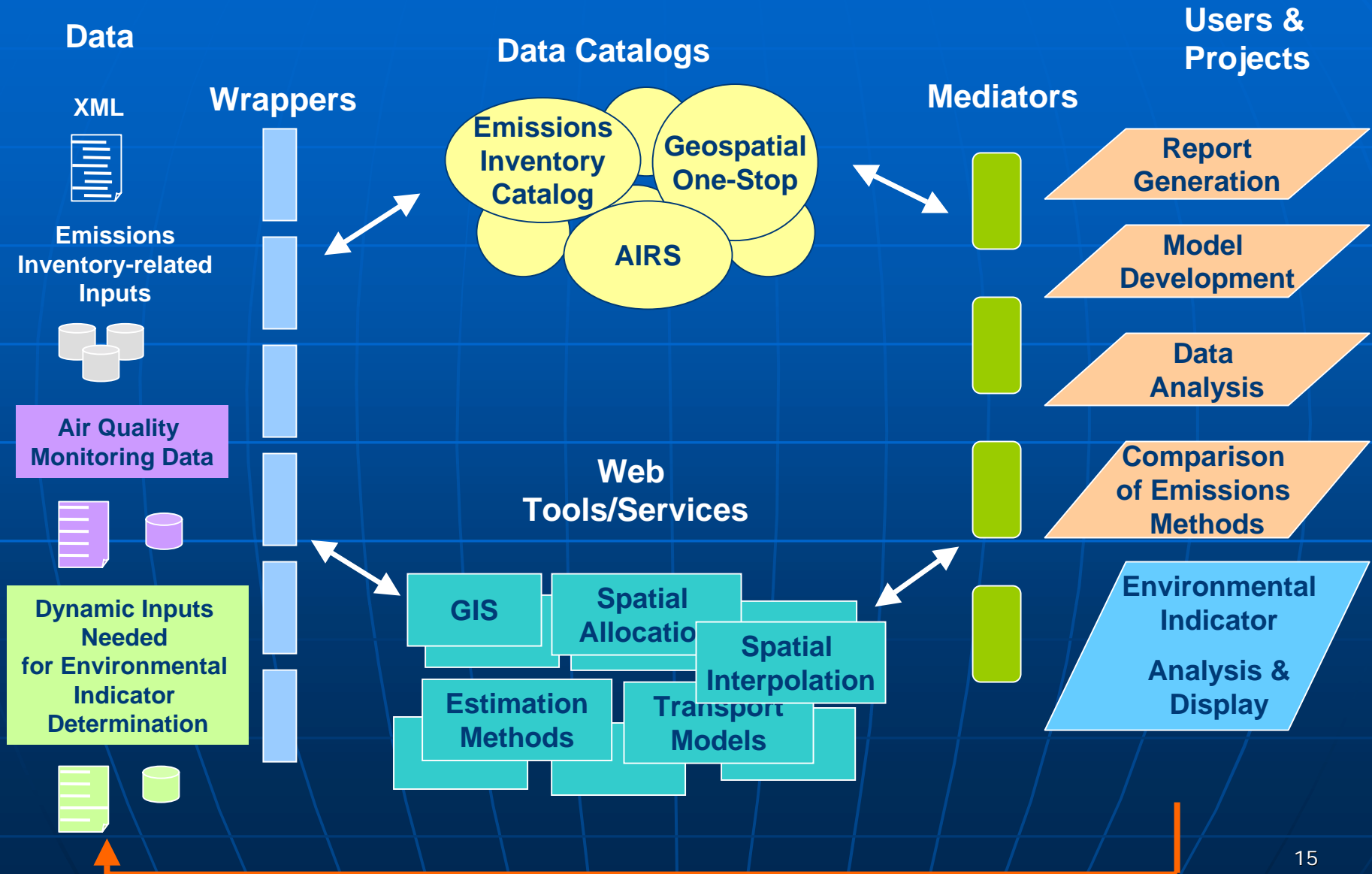
Extending the NEISGEI Framework to Create a Dynamic Environmental Indicator Panel

Data

Wrappers

Data Catalogs

Mediators

Users & Projects

XML

Emissions Inventory-related Inputs

Air Quality Monitoring Data

Dynamic Inputs Needed for Environmental Indicator Determination

Emissions Inventory Catalog

Geospatial One-Stop

AIRS

Web Tools/Services

GIS

Spatial Allocation

Spatial Interpolation

Estimation Methods

Transport Models

Report Generation

Model Development

Data Analysis

Comparison of Emissions Methods

Environmental Indicator

Analysis & Display

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Selection Criteria for Environmental Indicators	NEISGEI's Current Design Provisions
Primarily national in scale or scope, but drawing from state and county levels where possible Relevant to the main objective of assessing progress towards a healthy environment	The approach simplifies the **synthesis of the wide array of data**, at all geospatial scales and of any type, needed to derive policy-relevant indicators
…remaining open-ended and adaptable to future developments	**Powerful tools for exploring and visualizing** the indicators, their source and related data, are essential features
Dependant on data that are readily available or available at a reasonable cost to benefit ratio, adequately documented, of well known quality, and updated at regular intervals.	**Dynamic data access**: Not just a static document updated every 2-5 years. When data become available from the data source, they can be used on-the-fly to calculate the current values of the relevant indicators

# One Indicator Dashboard: UN Commission for Sustainable Development Indicator Dashboard for Europe

http://esl.jrc.it/dc/index.htm

Environmental Indicators Panel

Number of Days with AQI > 100
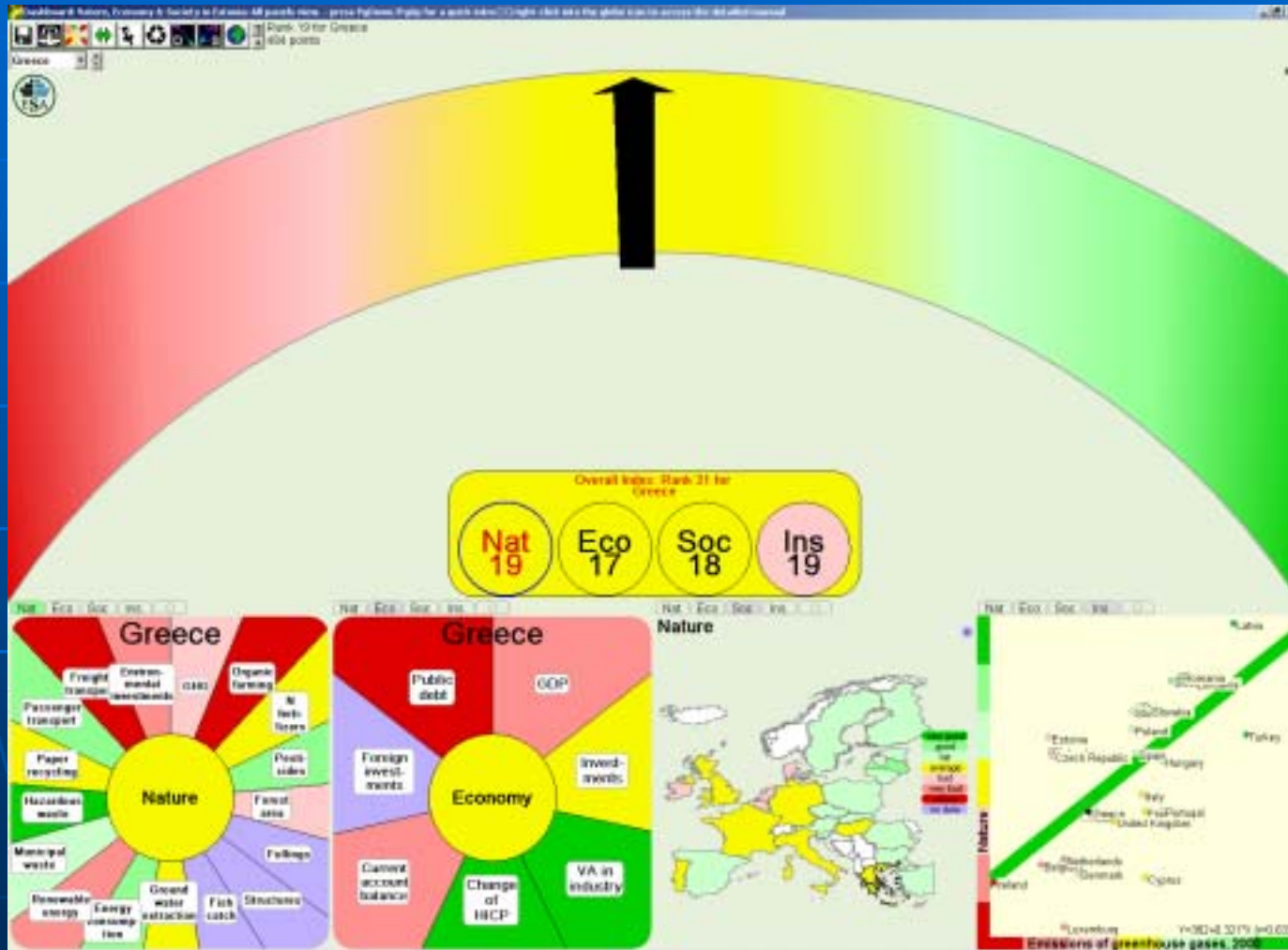
Indicator: Num Days AQI>100
Custom Query
Date: 2003 |< < > >|
Temporal Scale: Year
Temporal Analysis
Spatial Scale: MSA
Spatial Analysis

Other Analysis & Charts
Compare Dates | Compare Indicators
Compare Locations | Summary Statistics
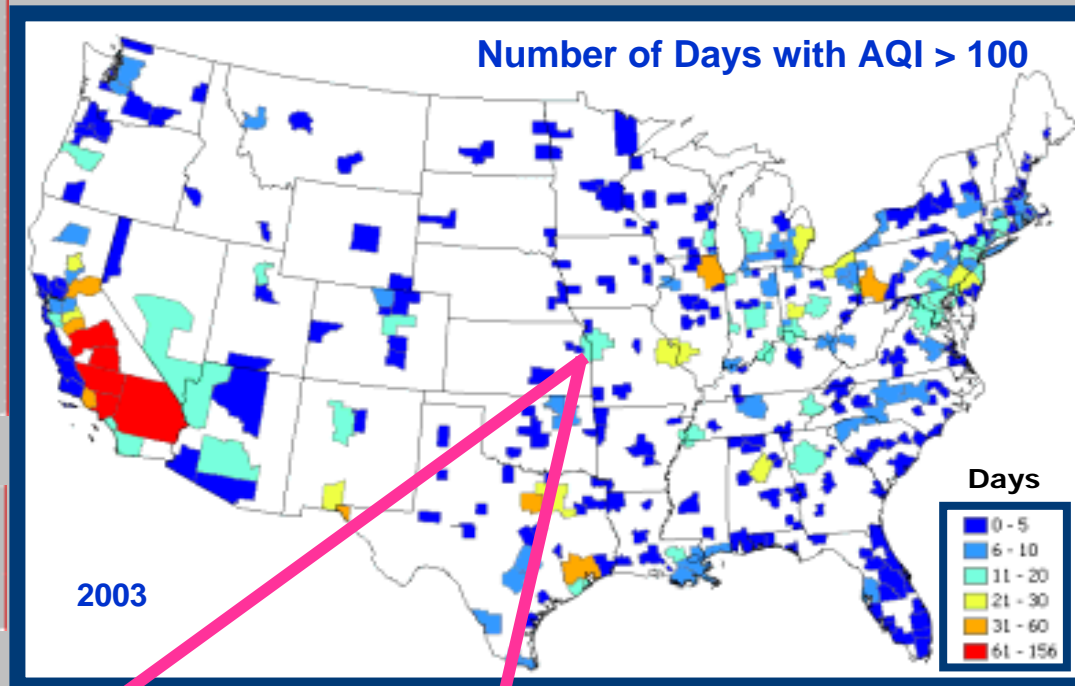
Data Layers
☑ Days AQI>100
☑ US States
☐ Population
Add Data

Days
- 0 - 5
- 6 - 10
- 11 - 20
- 21 - 30
- 31 - 60
- 61 - 156

2003

MSA	Kansas City, MO-KS
MSA Code	3760
State	KS
EPA Region	7
Days AQI=Good	172
Days AQI=Moderate	178
Days AQI=Unheal.Sens.	13
Days AQI=Unhealthy	2
Days AQI = CO	0
Days AQI = NO2	0
Days AQI = O3	136
Days AQI = SO2	14
Days AQI = PM2.5	210
Days AQI = PM10	5

Kansas City, 2003

Kansas City July 20, 2003

AQI data from EPA OAQPS AirData (http://www.epa.gov/air/data/)